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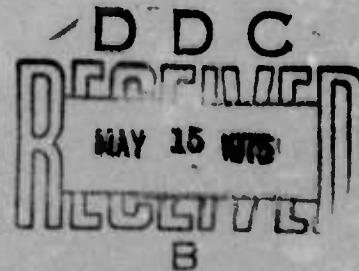
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DEVELOPMENT OF MHU-142/E MUNITIONS TRAILER

WILSON MACHINE COMPANY, INC.
POST OFFICE BOX 219
HUTCHINSON, KANSAS 67501

FEBRUARY 1975



FINAL REPORT: JUNE 1973 - JANUARY 1975

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for Munitions Handling Equipment.

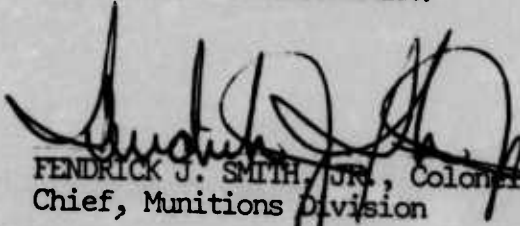
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PREFACE

This report was prepared by Wilson Machine Company, Inc., Hutchinson, Kansas 67501, under Contract F08635-73-C-0160 with the Air Force Armament Laboratory, Armament Development and Test Center, Eglin Air Force Base, Florida. This report covers work done during the period June 1973 through January 1975. Mr. B. B. Armbrester, Air Force Armament Laboratory (DLJA), was program manager for the Air Force.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER:



FENDRICK J. SMITH, JR., Colonel, USAF
Chief, Munitions Division

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SECTION I

INTRODUCTION

The MHU-142/E Munitions Trailer has been designed and fabricated by Wilson Machine Company, Inc., for the Air Force Armament Laboratory, Eglin Air Force Base, Florida, under Contract No. F08603-73-C-0160. This trailer is a light weight, tilt bed type vehicle having an extremely low vehicle cone index (VCI) rating coupled with excellent towing characteristics over rough terrain. It is of the two wheel trailer type with a lunette eye for attachment to the towing vehicle. Test results are documented in Reference 1.

The requirements for the trailer were as follows:

1. Capacity - 16,000 pounds consisting of any of the following:

MJ-1 Aerial Stores Lift Truck (3740 pounds)

or

MHU-83/E Aerial Stores Lift Truck (6320 pounds)

or

6000 pound Fork Lift Truck (9700 pounds)

or

Igloo Bomb Lift Truck (16,000 pounds)

2. Weight - Empty - 4000 pounds
3. Deck Height - 28 inches maximum
4. Overall Width - 96 inches maximum
5. Overall Length - 264 inches maximum (less lunette eye)
6. Loading Ramp Slope - 20 percent maximum
7. VCI₅₀ equal to 60 or less
8. Rough Terrain Mobility

These requirements represent the basic considerations for the preliminary design which is described in Section III.

¹Walks, R. E., Engineering Development of Shuttle Trailer for Munitions Handling Equipment, ADTC-TR-75-3, Armament Development and Test Center, Eglin AFB, Florida, February 1975.

At the preliminary design review (see Section III), possible trade-offs were discussed and the most desirable configuration of the prototype was defined. Detail design and fabrication followed immediately as further discussed in Section IV.

SECTION II

DESCRIPTION

1. **GENERAL.** Basic dimensions and general characteristics of the MHU-142/E Munitions Trailer are presented in Table 1. (Figures 1 through 4 are photographs of the completed prototype trailer.)

TABLE 1. DIMENSIONS AND GENERAL CHARACTERISTICS

Capacity	16,000 pounds	
Deck Height	27 inches	
Width	96 inches	
Length	275.13 inches	
Ground Clearance	14 inches	
Wheel Configuration	Single Tandem	
Suspension	Walking Beam	
Number of Wheels	4	
Tire Size	11.00 x 22, 12 ply rating	
Towing Speed	Concrete or Asphalt Road	30 mph
	Gravel Road	20 mph
	Rough Terrain	10 mph
Weight - Empty	5000 pounds	
Service Brakes	Inertia actuated on all wheels with breakaway feature	
Parking Brakes	Special mechanical - all wheels	
Lights	12 Volt	

2. **CHASSIS.** The trailer chassis consists of a main frame and a tilting top deck. Each is constructed of high strength, low alloy steel formed shapes. The tilt deck's top surface is a conventional tread plate of mild steel intermittently welded to form an integral stressed part of the structure beneath. The tilt bed incorporates two pair of main longitudinal formed channels with the flanges of each pair facing each other. These channels vary in height from 5 inches in the area directly over the main frame to a height of 12 inches at midspan of that portion of the deck that acts as a loading ramp when the deck is tilted to the ground. Gusset plates (1/8 inch) are welded between the two channels comprising each pair of longitudinal beams on 8 11/16-inch centers the full length of the tilt deck to aid in preventing web crippling and to brace the beams laterally. Five-inch-high by 2-inch-wide formed channels, spaced at 17 3/8 inches longitudinally, are used laterally between the two pair of main longitudinal beams. Outboard of the main longitudinal beams, 2-inch-wide formed



Figure 1. MHU-142/E Trailer with MHU-83/E in Transport Position

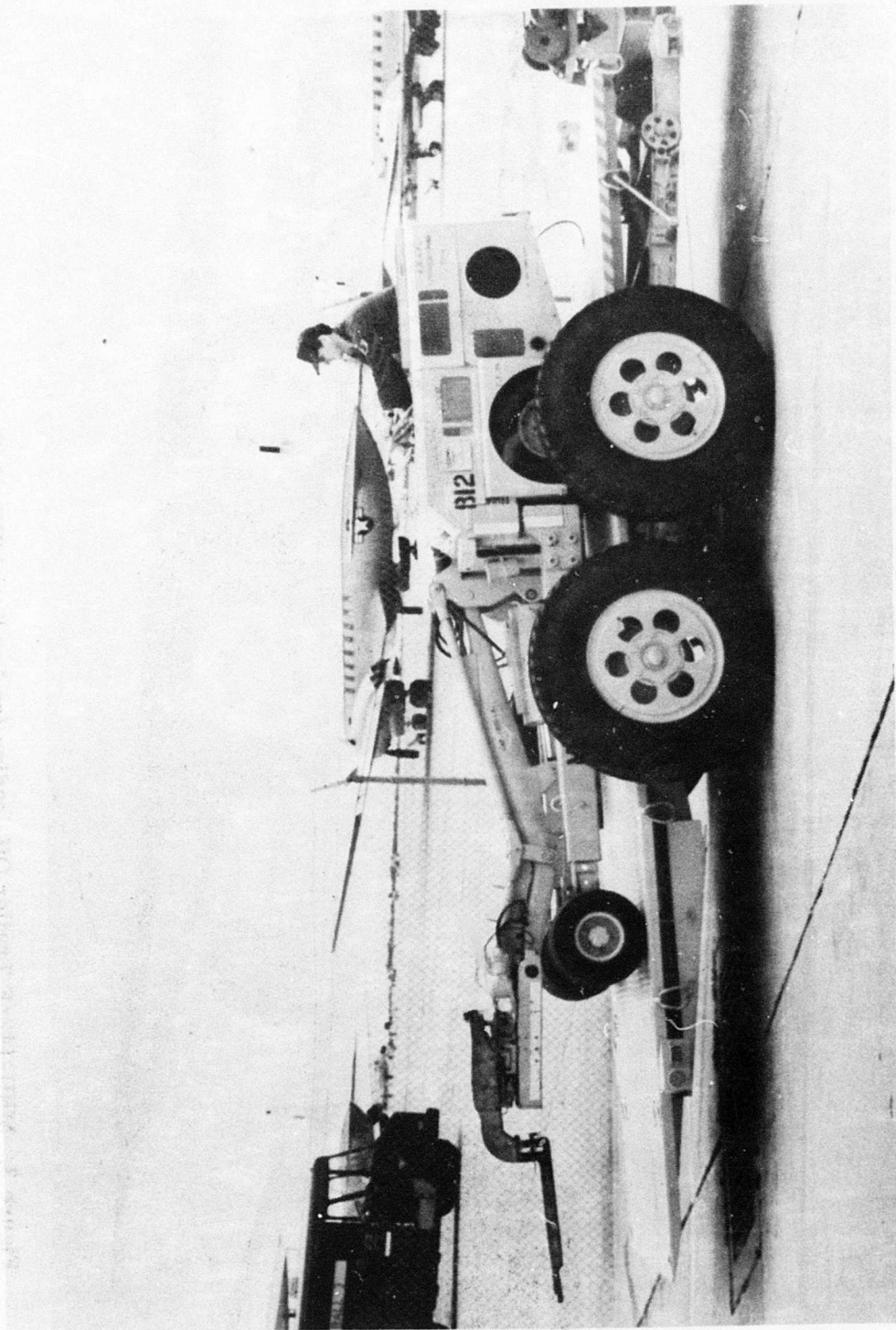


Figure 2. MHU-142/E Trailer Off-loading (or Loading) MHU-83/E at Moment of Tilt Bed Pivot

Figure 3. MHU-142/E Trailer Off-loading (or Loading) MHU-83/E with Tilt Bed Fully Tilted

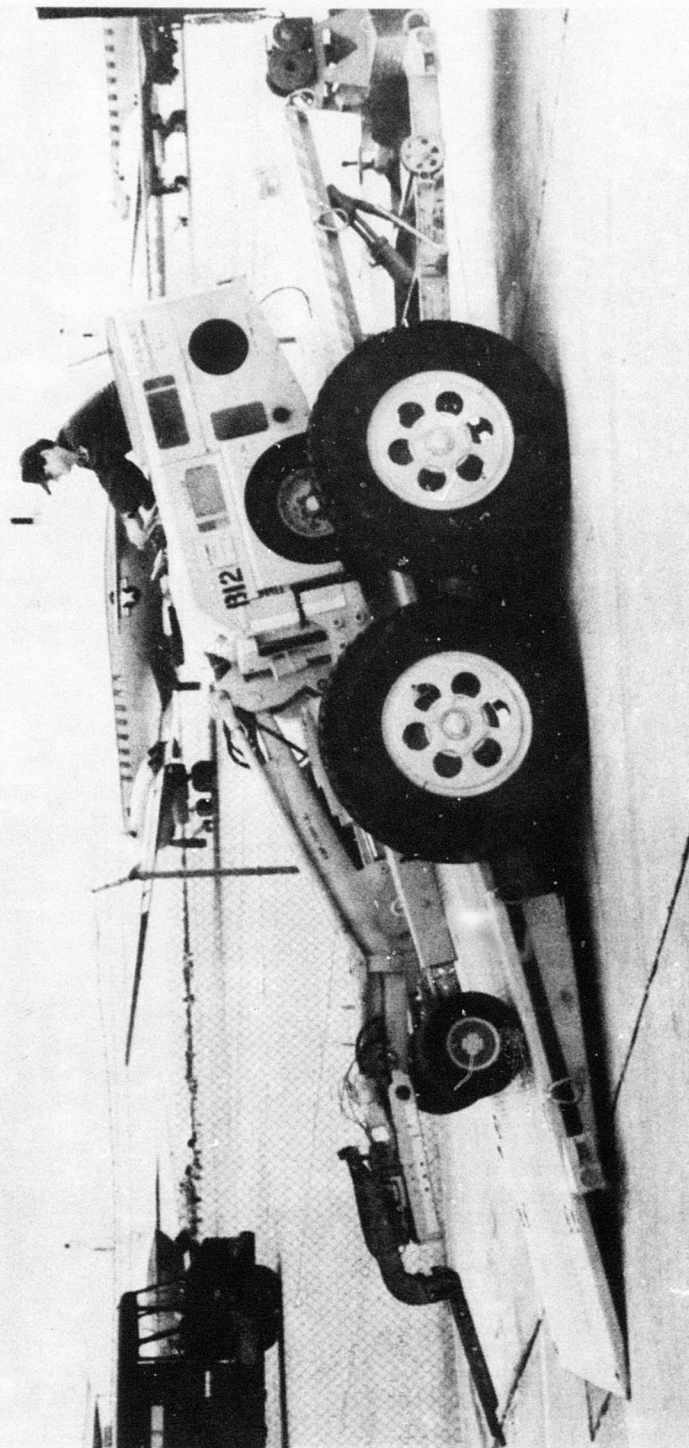


Figure 3. MHU-142/E Trailer Off-loading (or Loading) MHU-83/E with Tilt Bed Fully Tilted

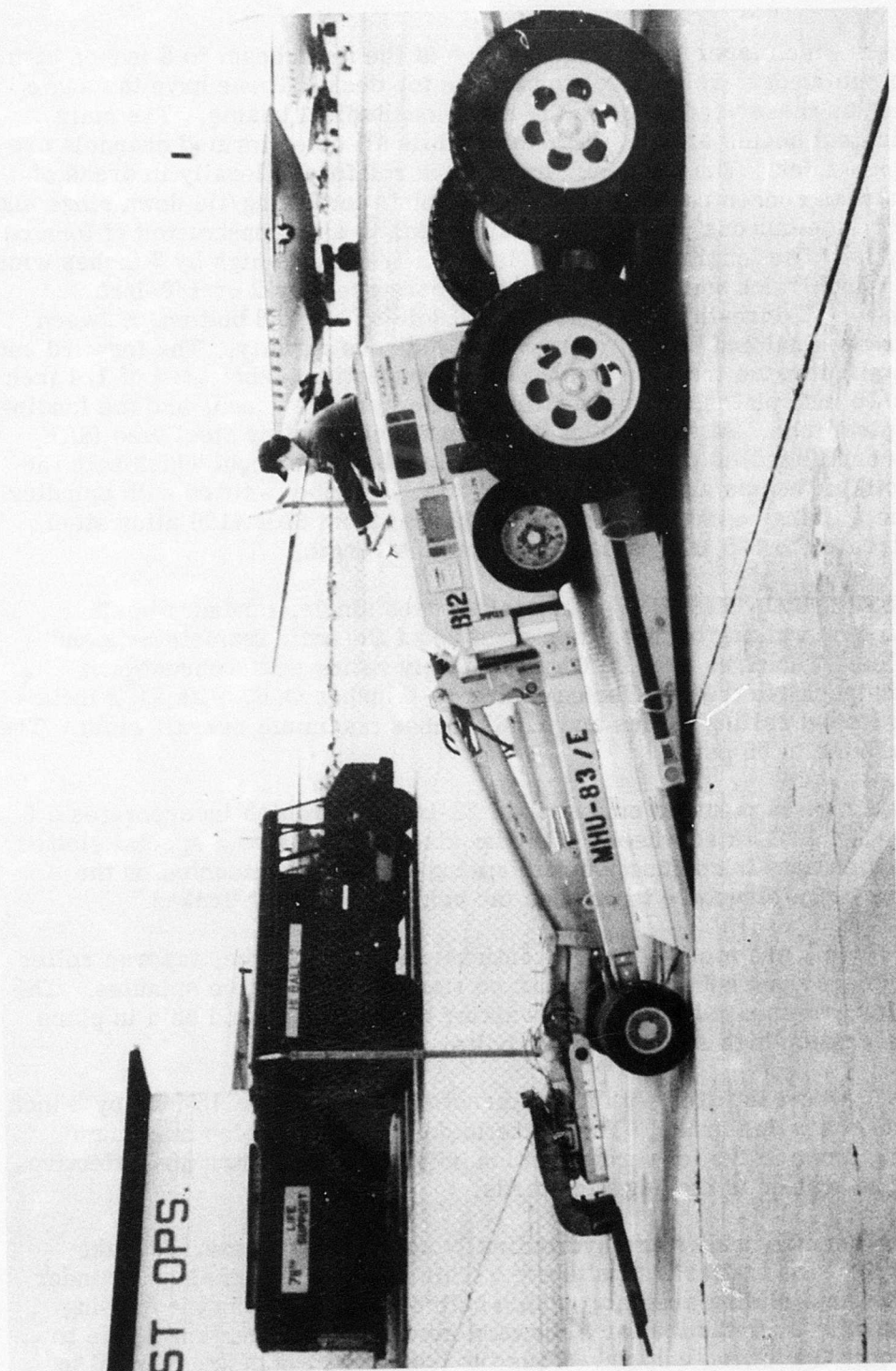


Figure 4. MHU-142/E Trailer Off-loading (or Loading) MHU-83/E at Moment of Ramp Departure
(or Entry)

channels which taper from 5 inches high at the main beam to 2 inches high at the outer edge are used to support the top deck. These have the same spacing as those used between the main longitudinal beams. The main longitudinal beams are 1/4-inch-thick while all other formed channels are 1/8-inch-thick. The tilt deck structure is reinforced locally in areas of high stress concentration and attaching points for lifting/tie down rings and other miscellaneous parts. The main frame is also constructed of formed channels. The longitudinal channels are 5 1/4 inches high by 3 inches wide by 1/4-inch-thick while the lateral members are 5 by 2 by 1/8-inch. Gussets (1/8-inch-thick) are used at all joints, top and bottom, between the longitudinal and lateral members to improve rigidity. The forward end of the main frame incorporates a heavy box section, fabricated of 1/4 inch and 3/16 inch plates, to support the lunette eye, the winch, and the landing gear pivot tube. At the rear of the main frame an alloy steel tube (SAE 4130 normalized) is provided to act as the main axle about which both the two walking beams and the tilt deck pivot. The tube is fitted with spindles for the walking beams. These are machined from SAE 4130 alloy steel heat treated to 125,000 psi minimum yield strength.

3. SUSPENSION SYSTEM. The trailer uses single, tandem wheels mounted on walking beams which pivot about the main frame's axle and spindles. The tires are 11.00 x 22, 12 ply rating with conventional trailer truck rib tread. The tires are 44.9 inches O.D. with 21.2 inches static loaded rolling radius and 11.62 inches maximum overall width. They are inflated to 55 psi.

Each tire is mounted on a special 22-inch-rim which incorporates a 5 hole 8-3/4 B.C. disc wheel. The rim also incorporates a special slotted disc which acts in conjunction with spring loaded pins mounted on the walking beam structure to provide the vehicle's parking brakes.

The rims are mounted to conventional automotive type, tapered roller bearing equipped hubs which rotate on standard automotive spindles. The spindles are stub mounted to the walking beam sockets and held in place with precision high strength cross bolts.

Each wheel is fitted with a uni-directional, shoe-type 15-inch by 3-inch hydraulic service brake. The brake is designed to develop maximum braking force in the forward direction only and is therefore non-effective when the trailer is moving backwards.

The service brakes are hydraulically actuated by an inertia brake actuator at the trailer's lunette eye. This actuator is a master cylinder mounted in a sliding assembly which builds up pressure in the braking system whenever the trailer's forward movement (momentum) tends to overcome the towing vehicle. Thus the trailer's brakes are applied in direct proportion to the deceleration of the tow vehicle up to the traction

limits of the tow vehicle. No hydraulic or electrical connection between the trailer and tow vehicle is required for brake operation. A small chain is provided for connection between the brake actuator and a frame member of the tow vehicle to accommodate the break-away feature. If the tow vehicle separates from the trailer, the chain is pulled actuating the master cylinder and applying the trailer's brakes.

The trailer's parking brakes are of special design. An actuation lever is located on the trailer's main frame on the right side forward of the forward right wheel. Spring loaded pins are located on the walking beam assemblies and function to engage slots in discs which are integral with the wheel and rim assemblies. Unlike conventional parking brakes, a force is required on the actuation lever to disengage the brakes rather than to engage them. The lever incorporates a sliding lock plate to lock the brakes in the disengaged position during transport. To set the brakes, the lock plate is disengaged from the lever allowing it to rotate thus permitting the spring loaded pins to stroke into engagement with a slot in each wheel's disc.

The walking beams are fabricated of SAE 4140 tubing, 6-inch O.D. by 5 1/2-inch I.D., stress relieved and heat treated after welding to 100,000 psi minimum yield strength. The spindle mount sockets are spaced at 25 inches forward and aft of the walking beam pivot. The pivot is fitted with high strength bronze bearings which are lubricated by pressure gun with MIL-G-7711 grease.

4. **DECK TILTING MECHANISM.** A geared mechanism is provided as a means of tilting the empty deck to the level, transport position. The operating handle is located on the trailer's right side forward of the parking brake lever. The device consists of a spur gear rack which is attached directly to the tilt deck and indirectly through two hydraulic cylinders to the main frame. The gear rack is powered by a pinion which is driven by a shaft attached to a bull gear located outboard of the main frame. The bull gear is powered by a crank which incorporates an integral pinion. A safety pawl is provided to prevent the tilt deck from tilting down toward the ground when the crank handle is released or removed. The two cylinders mentioned previously are piped such that they act as shock absorbers when the tilt deck is moving under the load of an MHE vehicle or when the empty deck is tilting to the ground. The cylinder piping has an integral needle valve which can be adjusted and locked at an appropriate opening to provide the desired shock absorbing action.

5. **ACCESSORIES.** The trailer is equipped with the following accessories.

- a. **Winch.** A 4000-pound capacity, manual 2 speed winch, mounted at the front end of the trailer, is provided for loading disabled MHE vehicles.

- b. **Ramp Toes.** Ramp toes, used to reduce the ramp slope as necessary for certain MHE vehicles, are also provided. They are stowed along the outboard sides of the tilt deck near the rear.
- c. **Landing Gear.** An adjustable, castered, dual pneumatic tire landing gear assembly is also included. It is designed to fold away when not in use. When deployed, it provides an adjustment of 4 inches up or 4 inches down to the lunette eye's normal height of 30 inches.
- d. **Tie Downs.** Eight tie down assemblies, USAF Types B-1A, are provided. These are used to secure various MHE vehicles during transport on the trailer.
- e. **Intervehicular Cable.** An intervehicular cable assembly is provided to connect the trailer's clearance, tail and stop lights to the tow vehicle's lighting system.

6. STOWAGE COMPARTMENT. Two stowage compartments, integral with the main frame, are located at the front of the trailer, one on each side on the lunette eye. They are adequate in size to stow the eight tie-down cable assemblies, the intervehicular cable assembly, the winch handle, and the tilting mechanism handle.

7. LIGHTING SYSTEM. The trailer is equipped with conventional 12 volt clearance, tail, stop and directional lights. In addition amber and red reflectors at the front and rear, respectively, are provided to improve night time identification.

SECTION III

PRELIMINARY DESIGN

Work on this program commenced in June 1973. The initial task was to accomplish a preliminary design which was capable of satisfying the basic design specification. Basic requirements were as follows:

1. Capacity - 16,000 pounds consisting of 1 MJ-1 Aerial Stores Lift Truck, or 1 MHU-83/E Aerial Stores Lift Truck, or 1 6000-pound fork lift truck, or 1 Igloo bomb lift truck.
2. Weight Empty - 4000 pounds.
3. Deck Height - 28 inches maximum.
4. Mobility - MIL-M-008090E(USAF) Type III
VCI₅₀ = 60 maximum.
5. Speed - 30 mph maximum.
6. Width - 96 inches maximum.
7. Length - 264 maximum (less lunette eye).
8. Brakes - Inertia actuated.

With these criteria, the preliminary design was completed and the Preliminary Design Review Conference was held at the Air Force Armament Laboratory (DLJC). Results of the conference were as follows:

1. It was decided that, in the interest of utilizing conventional components for the running gear, steel rims, hubs, and brake drums would be used in lieu of custom designed aluminum components. It was estimated at that time that this would result in a trailer weight of 4750 pounds, as opposed to the desired 4000 pounds, but that this would be offset by a significant savings in production unit costs and improved reliability.

2. Several possible shoe type brake assemblies were considered during the review conference. Only one type brake, the unidirectional shoe type, was considered to be adequate for the MIL-M-008090E(USAF) braking requirement; however, this brake is not available with a mechanical parking brake feature. Therefore, it was concluded that a special parking brake concept would be employed. The resulting design has been discussed in Section II of this report.

Upon conclusion of the preliminary design conference, the contractor was authorized to proceed with detail design and fabrication provided selected details relating to the special parking brakes would be discussed further as the design progressed.

SECTION IV

DETAIL DESIGN AND PROTOTYPE FABRICATION

Immediately following the preliminary design review conference described in Section III, detail design was started.

Design and fabrication were completed and the unit was shipped to Eglin AFB for testing. Subsequent testing was conducted by the Air Force Armament Laboratory.

On two different occasions during testing failures in the tilt bed structure at points of maximum stress concentration were experienced. The trailer was returned to the factory for corrective action. In each case, local reinforcement was considered to be the appropriate remedial action.

Subsequent to testing it was determined that in lieu of local reinforcement to the main longitudinal beams of the tilt bed structure, the drawings would be changed to require that they be formed from 1/4-inch-thick metal instead of the 1/8 inch thickness used originally. This would eliminate the need to weld 1/8 inch plates on the top and bottom flanges thus reducing labor costs in production while increasing the overall weight only slightly (100 pounds). The same change was made to the longitudinal members of the main frame.

A failure in one of the wheels was also experienced. The wheels were removed from the rims and replaced with thicker ones (1/2 inch versus 3/8 inch).

Subsequent to the above changes, the trailer passed all the tests satisfactorily. Observations during testing indicated that the trailer's suspension system is exceptionally well suited for transport over rough terrain. It trails the tow vehicle with excellent stability and no tendency to sway from side to side (fish tail) at any speed. The walking beam suspension system possessed excellent shock mitigation characteristics and has adequate pivot limits for all terrain encountered. Tow vehicle operators stated that they had difficulty realizing that they had a trailer in tow indicating that the trailer's resistance to rolling coupled with its shock mitigation capability are superior to most two wheel type trailers.

The failures encountered during rough terrain testing were attributed to the difficulty in predicting with certainty the levels of stress concen-

trations in thin, light weight formed structural shapes under extreme loading conditions. However, after reinforcements described above were made, it may be concluded that the trailer's structure now possesses a very high strength-to-weight ratio.

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